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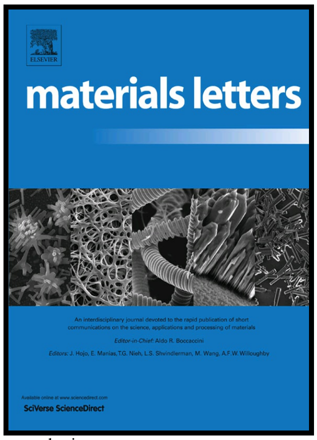

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Microstructural design of two-phase titanium alloys by micro-scale strain distribution

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Abstract

Micro-scale strain distribution, an integrated response of microstructural parameters, is crucial to designing the microstructure of two-phase titanium alloys. In this paper, a microstructure-based finite element model is used to analyze the effect of microstructural parameters, such as volume fraction and distribution of primary α (α_p), yield stress of transformed β (β_t) on micro-scale strain distribution of two-phase titanium alloys. Strain distribution factor (SDF) is proposed to quantitatively characterize the strain distribution. It is found that with increasing SDF the homogeneity of strain distribution increases. Decreasing yield stress of β_t and increasing volume fraction of α_p will increase SDF, whereas directional distribution of α_p will significantly decrease SDF. An SDF window for different α_p volume fractions and β_t yield stress is constructed, guiding the microstructural design of two-phase titanium alloy.

Keywords: Strain distribution, Microstructure, Metals and alloys, Simulation and modelling

1. Introduction

Two-phase titanium alloys have a unique microstructure containing soft primary α (α_p) and hard transformed β matrix (β_t). The combined effects of α_p and β_t with different volume fractions, distributions and mechanical properties can give titanium alloys high tensile strength or high ductility [1-3]. As a result, microstructural design can provide titanium alloys with excellent properties. Therefore, titanium alloys can meet the high service requirement widely used in the aviation and aerospace industries [4-6].

To design the microstructure of titanium alloys, Kar et al. [7] analyzed the influence of microstructure on the mechanical properties of Ti-5553, and pointed out that with increasing volume fraction of α_p ($V_{\alpha p}$), the yield strength of the alloy decreases. Wang et al. [8] produced a series of microstructures of TG6 titanium alloy with $V_{\alpha p}$ of 15.1% to 40.5% and thickness of lamellar α of 0.4